

Office of Technical Assistance Research Proposal
Solvent-based Industrial Coatings Utilizing Low-VOC Solvents

Background

Paints and coatings are used primarily for decoration and protection when applied to structures and products. They are normally liquid compositions which dry to form well-adhering films on surfaces. Solvents and diluents are used to varying degrees in the manufacture of the coating and in the application of the coating. Generally, more solvent is required for coatings formulated with high molecular weight homogeneous binders. Generally less solvent is needed for coatings formulated with lower molecular weight binders that also incorporate a chemical drying mechanism. Coatings may also be dispersed (emulsified) in an organic thinner or in water.

However, there are instances where manufacturers don't want to coat their products with water-based coatings. Water may adversely affect some surfaces such as rusting of steel or grain raising of wood or distortion of hydrophilic fibers. Water soluble stains may bleed through water-based coatings. Also, wetting and adhesion may be more difficult without additional cleaning, surface treatments, or priming. Furthermore, drying may take longer or even be difficult on humid days without heating or climate control in the shop.

Most organic solvents have been considered by EPA to be air pollutants in the category of "VOC" (volatile organic compound), if not a "HAP" (hazardous air pollutant). Their use is regulated by maximum content allowed per unit of coating. Smaller industrial sources are permitted for specific levels of uncontrolled emissions. Larger sources are likely to be required to have high capture and / or destruct rates.

Scope of Problem

National:

U.S. paint production is considered a mature industry with modest growth rates. Products and formulations continue to evolve each year and larger volumes are produced each year by fewer companies from fewer facilities. There were 1580 firms producing from 1800 plants in 1963, and approximately 500 plants producing from 700 plants in 1997.

In 1997, approximately 1.14 billion gallons of paints and coatings were consumed in the United States. 46% of this for Architectural Coatings, 40% for Product Finishes, and 15% for Special-Purpose Coatings. In the mid-70's low solids solvent-based systems accounted for nearly 80% of the Product Finishes market. By 1998, new coatings technologies such as waterborne, high-solids, and powder coating systems gained market share in this category to about 65%. However, some manufacturers have had difficulty in adopting the new coatings technologies. Low-solids solvent-based alkyds continue to predominate in the Machinery & Equipment category (with the exception of office and business machines). In the Special Purpose category the "high-performance and marine

coatings” are also still primarily solventborne epoxies and polyurethanes (followed by vinyls, chlorinated rubber and inorganic silicate primers).

Massachusetts:

One of the most commonly used solvents is Toluene, which is not only a VOC, but also a HAP. In 1998, 75 Massachusetts companies reported using 37,918,838 pounds of toluene [23,386,000 pounds “processed” and 14,532,572 pounds “otherwise used”]. Other individual solvents are reported in lesser amounts (e.g., 5,442,000 pounds of mixed xylene isomers used by 44 Massachusetts companies). Considerable quantities of “paint thinner” and “VM&P Naphtha” are used, but unreported because they are varying mixtures of many solvent constituents.

Objectives

Paint manufacturers and industrial users continue to seek modified or new coatings that meet their requirements for appearance and performance while at the same time having less harmful emissions during application and cure. Environmental regulations have set standards for maximum VOC and HAP contents of various coating categories while at the same time a few solvents have been delisted as VOCs and as HAPs.

EPA, after considerable study has exempted acetone and methyl acetate from the VOC category and is considering the same for t-butyl acetate. Auto Refinishers are said to be substituting acetone in their laquer formulations. California has a new regulation for aerosol coating products which regulates the VOC content by the relative photoactivities of the hydrocarbon constituents. Maximum Incremental Reactivities have been assigned to the 700 most commonly used organic compounds. It is not likely that EPA or Massachussets will adopt something quite this elaborate, however, there is some movement in this direction.

Scope of Work

This project would require the identification of resins (or polymers) with equivalent performance properties that could be substituted for the resins and polymers in existing industrial coatings for metals such as steel that would be more soluble (or less insoluble) in low-VOC solvents such as acetone, methyl acetate, or t-butyl acetate. Halogenated solvents such as methylene chloride should be excluded from consideration. These alternative resins should then be formulated into industrial coatings with significantly less content of solvents like toluene and xylene which may be substituted, in part, with the previously mentioned low-VOC solvents. Finally, the coatings should be application tested.

OTA can assist in the identification of an industry partner.